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MOSFET and oscillator compose relay

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Combining a dense-cell n-channel power MOSFET and a quad exclusive-or oscillator makes an effective solid-state relay. **Fig 1**'s capacitively isolated drive circuit provides sufficient gate drive to ensure full turn-on of the n-channel device. This gate circuit consists of a gated oscillator (IC_{1A} and IC_{1B}) running at 500 kHz set by R_1, R_2, and C_1. IC_{1C} and IC_{1D} buffer the oscillator output, provide complementary outputs, and drive the isolating capacitors C_2 and C_3. These capacitors provide charge transfer between the oscillator and the floating gate circuit of the MOSFET, Q_1.

The diode bridge comprising D_1 through D_4 rectifies the charge transferred through C_2 and C_3. The bridge produces a dc voltage at the MOSFET's gate that is equal to the oscillator's supply voltage. When you disable the oscillator, R_3 discharges the stored gate charge, thereby turning off the MOSFET. R_3 needs to allow fast turn-off times without loading the gate's enhancement voltage. A value of 10-kΩ is sufficient to produce a turn-off time of 800 μsec with an 18-mΩ SMP60N06-18 MOSFET. The measured turn-on time is 150 μsec.

If the values of C_2 and C_3 don't match, timing errors between the complementary outputs can cause low-level clock frequency spikes to appear at the load terminal. A simple LC filter at the output eliminates these spikes. You can reduce the turn-off time to 100 μsec by using a pnp transistor as a diode-steering emitter-follower in the MOSFET gate circuit (**Fig 2**). The additional 4050 CMOS hex buffer in **Fig 3** increases the drive capability of the complementary outputs, thereby increasing the loading of the gate circuit and further reducing turn-off time.

The SMP60N06-18 is a 60V, 18-mΩ device; it will survive 60V transients. If higher voltages are likely to occur, MOSFETs with 100V ratings are available. You can protect the CMOS driver against transients above 15V by adding a zener diode and resistor network at the IC's power-supply pin. EDN

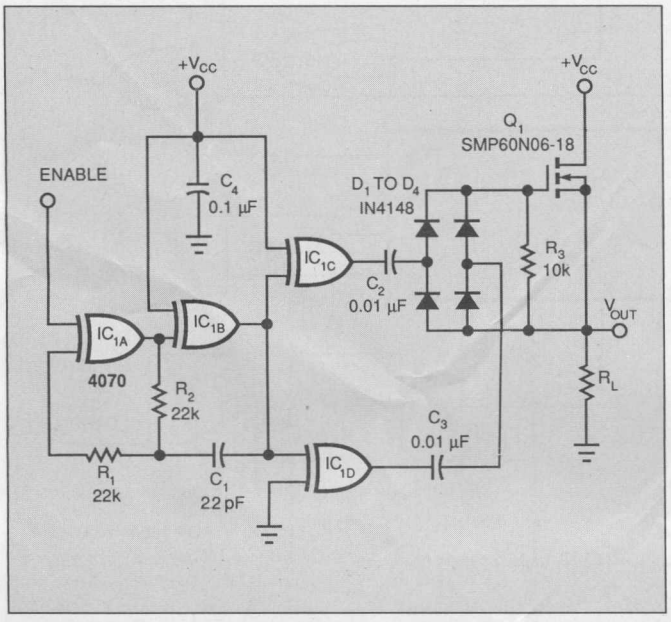

Fig 1—This solid-state relay's capacitively coupled drive circuit, *IC_{1A} through IC_{1D}, provides sufficient gate drive to ensure that the n-channel MOSFET fully turns on.*

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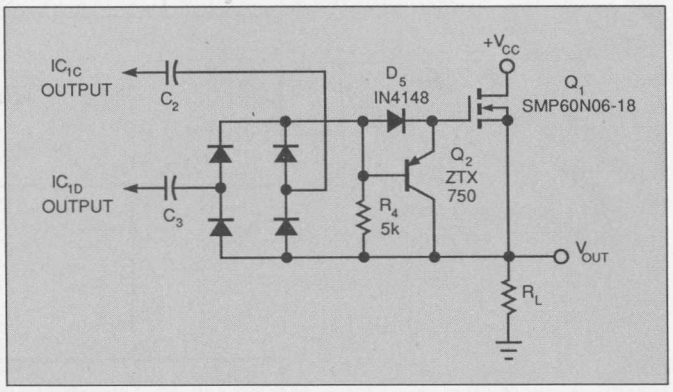

Fig 2—Adding a pnp transistor to Fig 1's circuit *reduces the turn-off time from 800 to 100 μsec.*

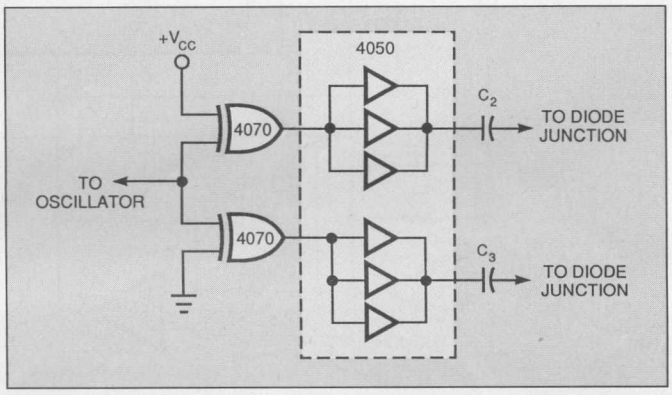

Fig 3—Adding a hex buffer to Fig 1's circuit *increases the drive capability of the complementary outputs.*